SEKISUI

Q&A Summary
Briefing about Perovskite Solar Cell Business

Date: Jan. 7, 2025

Q: How will the profit curve evolve in the future? It seems you have planned for losses that exceed one billion yen this fiscal year, but will these losses grow or contract? Although it might be difficult to provide specific numbers, what will profitability look like in FY2030? Please comment on profits.

A: (Kamiwaki) We plan to see losses for the foreseeable future since we are still at the stage prior to the start of construction. After commissioning a 100MW plant in 2028, we assume we can enter positive territory about the time it reaches a volume close to full production capacity. We also expect to see economies of scale and lower costs around the time the 1GW plant comes online, and feel we can establish a business with an operating profit margin of around 10%, although this is just an estimate.

Q: Given that the plan calls for net sales of ¥25 billion at 100MW in 2028, the price per module on a KW basis stands at ¥250,000. Assuming a lifespan of 10 years and a power generation capacity of 1,000KWh at 1KW, I believe this comes to ¥25. If we assume this cost does not include any other expenses like power conditioners, then the power generation costs for customers will be ¥40 or ¥50. This seems to be fairly high. Will these solar cells be used widely at this cost?

A: (Kamiwaki) We assume that 100MW applies to the wind-up period, which makes the costs from a user standpoint seem high when compared with silicon. However, our assumption for 2028 is that we can expect to see the government offer some degree of subsidies for users. As long as users take advantage of these, this will create a situation where prices will equal those of silicon so that users will choose perovskite for its higher quality.

Q: What areas will you initially target? With options including gymnasiums, factories, and buildings, should we assume most will be roofs? Can these solar cells be used on surfaces like walls and windows? Costs faced by the user will likely increase further when taking into consideration that these kinds of surfaces generate less electricity, so would these still be an option?

A: (Kamiwaki) During the introductory phase one target will include public, defense outpost, and other facilities, as long as we assume some degree of user subsidies from the government. There are a significant number of facilities that cannot be equipped with silicon solar cells because the load capacity of their roofs is not that high, so we intend to prioritize them as targets for shipments from the 100MW plant since they can take advantage of the lighter weight.

Q: How many square meters is a 1KW system?

A: (Morita) Based on a simple calculation, a conversion efficiency of 15%, for example, would result in an output of 150W per square meter for the effective area contributing to power generation. If we reach our target of 20% as planned, then one square meter will produce 200W.

Q: What will the power generation cost in 2030 look like, and, if available, what would it be in 2040? According to materials released by the Ministry of Economy, Trade and Industry, demand forecasts vary considerably depending on the cost of power generation, so I would like to know your thoughts on this.

A: (Kamiwaki) When the total life-cycle cost, including materials, installation, and disposal, is converted to power generation costs, we aim to achieve a similar level as silicon in 2030 for 1GW as seen from the user standpoint. When the unit increases significantly to 20GW in 2040, we believe users can expect to see total costs fall below those of silicon.

Q: Can we assume that power generation costs in 2030 will be about ¥14/KWh?

A: (Kamiwaki) At the current time we see the costs as around ¥20 in 2030. I believe reaching ¥14 will require further economies of scale.

Q: To what degree will you in-house the production processes? The Ministry of Economy, Trade and Industry will also likely offer subsidies for equipment, but what are the main components that you will purchase from external sources? Will any of these result in a production bottle neck?

A: (Morita) To begin with, stability and reliability will become important at the initial stages, so we will also likely procure barrier films and other relatively expensive components from outside. Recognizing that barrier films account for an extremely high ratio of the total cost, however, we began developing these on our own several years ago. We intend to set the timing to introduce these as we identify just how far increasing volumes will drive costs down, although this depends in part on our relationships with suppliers. Barrier films and sealants will also be the key to technical developments involving durability. NEDO aims to achieve a 20-year durability by the next fiscal year, so we intend to progress with these developments after firmly deciding on our own targets, including how far we can consistently achieve this level on a mass-production basis. When we reach the 1GW level in 2030, we intend to operate under the assumption of in-house production.

Q: What about overseas expansion? Based on your explanations thus far, the main targets appear to be domestic, but are you considering overseas expansion for the future? Also, what is the

competition like overseas? It seems that quite a few Chinese manufacturers have emerged, but can you compete with them when you do expand overseas?

A: (Kato) Japan is placing a greater importance on perovskite, which is made from iodine, from the perspective of economic security, whereas overseas we are aware that the US and Europe are likely deeply interested because of their desire to prevent Chinese-made silicon panels from dominating the market. In the interlayer film business, for example, our experience has included serving customers through exports until we were able to capture market demand, after which we found local partners to increase sales as we commissioned local plants at the point we could foresee a certain level of demand. We therefore feel that overseas expansion is certainly possible from a variety of perspectives, including robust demand and the economic security of different countries.

Q: I would like to ask about the challenges in achieving a durability of 20 years. Are materials like barrier films and sealants the issue, or is this a question of assembly?

A: (Morita) As far as barrier, sealant, and other technical issues are concerned, we are close to establishing an outlook for a 20-year durability when looking solely at performance. What becomes extremely important here is how to achieve this durability without greatly increasing costs. Perovskite is considered to be susceptible to moisture, yet it is also easily affected by light and heat. It will sometimes degrade under light alone even when completely encapsulated in glass, which is why we are working to solve these issues by looking at both the sealant as well as the materials in the generation layer. We are also considering long-term deterioration and durability versus humidity in conjunction with costs. At the same time, we intend to accelerate these developments in line with the degree to which economies of scale can reduce costs, and with the support of the government.

Q: Although iodine's use in the generation layer is considered standard, I believe some relatively recent overseas papers have stated that using bromine instead of iodine results in greater efficiency. Have you already settled on using iodine? Please tell us about the technical side of this.

A: (Morita) There are still several options among our tie-ups with universities. As far as we are concerned, however, we are focused on durability as well as enhancing efficiency. Simply pursuing conversion efficiency alone would be a waste of time, if we were to select materials that rapidly deteriorated outdoors or deteriorated in the roll-to-roll systems used to produce several hundred meters. With a priority on durability, our strategy over the past ten years has aimed to increase the conversion efficiency in durable solar cells.

Q: Is my understanding correct that increasing durability without raising costs relies heavily on the yield, width, and volume of roll-to-roll systems?

A: (Morita) That is correct. After considering durability, the question shifts to increasing power generation efficiency to reduce power generation costs. More than reducing the price of the solar cells themselves, however, the purpose here is to ensure the solar cells operate maintenance-free over the long term so as to reduce costs as much as possible over the product life cycle up to disposal. The question is whether we can provide solar cells that can contribute to our customers, not in terms of yen/W, but of yen/KWh. Our focus is therefore on development that takes this kind of overarching view.

Q: As you seek to expand to a 1GW business in the future, will there be any problems in procuring iodine? As Japan is the second largest producer of iodine after Chili, the Ministry of Economy, Trade and Industry has stated that this will constitute a kind of barrier to entry, but will this truly be an advantage for Japan? At this point, the concentration of iodine in Japan simply meets industrial needs, but if properly extracted, it seems other countries could also acquire iodine, even if the concentration is low. Please tell us your thoughts on this area.

A: (Morita) The thickness of conventional silicon solar cell generation layers is 100μm, yet no matter how many layers of iodine are coated together to produce perovskite solar cells, this layer still remains less than 1μm thick. Because this also means we need very little iodine as a material, we do not have any concerns over iodine procurement. However, just because we have access to iodine, does not mean that we can beat out overseas competition. Perovskite solar cells differ from silicon solar cells, which are made by simply combining several different materials like silicon wafers and glass. Instead, these are a nexus of the areas in which Japanese companies excel, like materials, processes, and converting. In other words, this is an area in which competition should rely on the content, which is why we feel the barriers to entry are fairly high.

Q: You explained that you will install perovskite solar cells around the time the crystalline solar cells on your houses deteriorate, but how realistic is this?

A: (Kato) As a possibility, we foresee increases in life-cycle costs around the late 2030s when silicon solar cells reach the end of their lives, for example with new laws enacted that will require the glass to be separated before disposal. For example, when the silicon solar panels at large-scale power utilities reach the end of their lives, it might be possible to simply place perovskite solar cells over the top because the frames and wiring are already located facing directions with good sunlight, which we believe holds the potential to delay disposal. We do believe there is sufficient potential here, although we will have to verify Japan's statutory developments, as well as the outcomes and impacts when actually placed over the top.

Q: As far as future production line plans are concerned, why does the investment decline from ¥90 billion for the first 100MW production line to ¥43 billion for the second line? Will the third production line for 600 to 800MW really only cost ¥180 billion? Can you please provide more information on the details of these investments totaling more than ¥310 billion?

A: (Kamiwaki) The first phase of investment includes around ¥25 billion for the building. Moreover, the weight of the basic investments to begin production, like the initial utilities and systems, is fairly high, which makes the initial investment appear high compared to the second phase. The second and third lines primarily involve additional equipment, which is the reason the degree of increase seems small.

Q: You said the second line investment decision will depend on demand trends, but what will you need to see before giving the go sign? It seems like the timing is quite near. What are your thoughts at this time?

A: (Kamiwaki) One of the key points for making the investment decision is demand, particularly whether defense outposts and other demand exploration proceeds as expected. Another key decision point is technical, namely whether costs and power generation efficiency have cleared certain milestones.

Q: When moving from the second to the third line, why doesn't the investment amount increase to the same degree as the increase in production capacity, for example the result of multiplying the ¥43 billion for the second line by a factor of six or eight?

A: (Kamiwaki) The third production line will be much larger. So, you can assume this is based on the scale of the equipment.

Q: Can we assume that you are not at present planning on installing these perovskite solar cells on SEKISUI HEIM homes in the near future?

A: (Kato) As far as priorities are concerned, this approach will likely come a bit later. Starting in FY2025, we will install these on the roofs of existing facilities, such as defense outposts throughout Japan. As the subsidies provided by the government for this purpose and demand become clear, we feel that 100MW will unlikely be enough to meet this demand, so will probably make a decision on the second line in light of this. For the time being, until the business stands on its own at 1GW with the third line, and the solar cells reach a similar level as silicon, we feel that the priority will be on targets that use subsidies to install them.

Q: At the present time, where the first production line is not fully operational, what is the annual production capacity?

A: (Morita) We are currently developing the technology for meter-wide production, and once this line is complete, production volume will reach just about one-tenth of the 100MW line. We will use this to start market verification and other aspects of commercialization.

Q: You explained that you are the only company using roll-to-roll technology. Even though I

understand that silicon solar cells are basically produced as individual sheets, why are the costs of roll-to-roll so high despite the high productivity? I assume this approach shares the same challenge as OLEDs, namely the vacuum deposition processes, but please tell us if there are any other major challenges. Assuming the same challenges as OLEDs do exist, I understand that at present the reason why OLED panels, for which the material costs are exceedingly cheap, have not made much headway is because of the high difficulty of working with roll-to-roll vacuum processes, in turn making it difficult to reduce costs. Will your perovskite solar cells be able to overcome this hurdle? Are there any other major obstacles to reducing costs?

A: (Morita) We do not feel that the vacuum processes are a cost bottle-neck for us. Our generation layers are extremely thin at a total of less than 1μm, meaning even the vacuum deposition layers can be deposited at a fairly high speed. In fact, the solar cells themselves account for a small part of the total cost, while it is the sealant, barrier film, and other peripheral materials used to produce the modules that account for a larger part. Progress in the development of a complete roll-to-roll process, including the vacuum processes, will increase the line speed, as well as the volume we can produce using the same equipment. In other words, we can reduce costs by increasing productivity given that the ratio of the total cost accounted for by the raw materials is relatively low. This is why we believe we can defeat silicon in the future.

Q: The sealant, I believe, is essentially two films for the front and back sides. The reason this is expensive today is because the market is small, meaning economies of scale should come into play if the market grows. Am I correct in assuming that you also expect to see the costs dramatically drop?

A: (Morita) Exactly. There is plenty of room for reducing costs, and to some extent this is why we must shift to in-house production wherever possible. Although it will be a challenge, because we possess these kinds of technologies, we also feel this will, in fact, become a source of enduring competitiveness.

Q: There are likely several band gaps based on the structure, and I am aware that, unlike silicon, perovskite does not rely on a single conversion. Moreover, I understand that perovskite is able to convert light over a longer duration when the conversion efficiency is the same, which increases the actual amount generated. Is this correct?

A: (Morita) Exactly. We also feel that this is a source of competitiveness for us. At the present time, the industry lacks international standards for measuring perovskite solar cell power generation efficiency, yet we feel the situation is such that we are the only company that can offer solar cells with good durability. Currently, we have reached the point of proposing a basic draft to perform these measurements, and we feel that this will likely become the international standard. As we keep this kind of framework in mind, we also hope to lead the effort to formulate international standards for durability as well. We also envision the framework for this as involving various related organizations, like JET and JEMA, in addition to SEKISUI CHEMICAL.

Q: What about environmental issues? Will the use of a trace amount of lead become an obstacle to future mass production? Please explain this in terms of recycling as well.

A: (Morita) We recognize a problem in that these contain lead along with iodine. However, the amount is extremely small, and we are advancing environmental impact assessments to determine just how much of an actual impact this has on the environment. In parallel, we are discussing the issues with environmental experts, even as we plan to begin by taking responsibility for recovering these when possible as a public service until the outcomes become clear. Despite being easy to recycle, the volume is far too low, which means any attempt at recycling would require collecting huge amounts of solar cells. It is my belief, for example, that in combination with the biorefinery technology that we are developing, we could potentially collect the lead little by little for use elsewhere. Amassing 10,000 square meters of perovskite solar cells would only produce just enough lead for one lead acid battery, however, so the volume is extremely small. Although the issue remains over what we will do going forward, at the present time, our basic stance is to take responsibility for disposal.

Q: Because they are extremely light, I can clearly imagine that these will be used on gymnasiums and other buildings on which silicon solar cells cannot be installed. From a flexibility perspective, can you give us any concrete examples of the applications for which these can be used by bending?

A: (Morita) In general, solar cells have a shorter lifespan than buildings, so their light weight becomes a key point when considering the ease of replacement as a prerequisite. As far as shape conformity is concerned, you could say that these can be shaped to match different areas during installation. Silicon solar cells can be installed anywhere a frame needs to be installed, or installed all at once from a roof along a rail on the side of a building. Which means ¥14/KW requires keeping the total cost, including installation, as low as possible, and becomes a very important issue that involves partners.

Q: What are the differences in your business models from those for silicon solar cells? Silicon boomed fifteen and twenty years ago in part because of government support and FIT, yet all of a sudden domestic manufacturers fell into the red and withdrew from the industry. I would like to ask about where the differences lie that will prevent this from happening again.

A: (Kato) The greatest difference is that the majority of raw materials for silicon solar cells relied on China. It was therefore necessary to import the raw materials, and Japan fell to the weight of China's overwhelming cost competitiveness as it was the country in possession. In the case of our perovskite solar cells, we can acquire the raw materials domestically. Furthermore, we believe we can sufficiently lower the cost of the expensive sealants by shifting to in-house production in the future. Another difference is that there are almost no areas of level ground left in Japan. At present, silicon solar cells are used to generate power in the countryside at golf courses and fields, after which the electricity is transmitted to cities and demand centers, so involves power transmission loss and costs. In comparison, perovskite enables local production for local consumption, which we recognize as an overwhelming strength. Although this is still a bit further out in the future, if they can be placed on private home roofs that have a low load bearing capacity, we believe this will create sufficient business potential given the advantages and differentiation enabled by perovskite.

Q: Would it be possible to compete if two companies worked together, for example one that made the generation layer and one that handled the processes? I do however understand that one of your strengths is that you can do both.

A: (Morita) The equipment that we possess itself must reduce overall costs, which is why, in part, we do not use anything particularly special. However, the combination with materials that suit this equipment, improvements to the equipment itself, and minor changes that we have made, have allowed us to perfect these through both materials and processes, which is our strength.